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## MINERALOGY AND PETROGRAPHY.[1]

**Petrographical News.**—Several contributions to the subject of the origin of spherulites have recently been made by Messrs. Cross and Iddings, and one on the minerals occurring in hollow spherulites by the latter gentleman and Penfield. Iddings[2] distinguishes two kinds of spherulites; one composed of radial fibres forming the compact spherulite; and the second consisting of jointed and branching fibres of feldspar, separated by tridymite scales and gas cavities. Gradations between small, dense spherulites composed of micro-felsite, and large ones, the nature of whose structure can be determined, were traced in many instances, and from them the conclusion is reached that microfelsite is in many cases but a microscopic intergrowth of feldspars, elongated parallel to the clino-axis, and quartz, and that the spherulites are but special phases of granophyric growths. The discovery of tourmaline and mica, especially near the margins of spherulites, is an additional proof of the correctness of Iddings' view that spherulites are the result of crystallization of pasty rhyolitic magma under the influence of moisture. These two minerals are younger than the smaller compact radial spherulites of the rock, and older than the final crystallization of the residual magma between the spherulites. In the porous spherulites with branching fibres, or the lityophysae, some of the fibres are negative and others positive in the nature of their double refraction; that is, some are orthoclase crystals elongated parallel to *c*, with the plane of the optical axes normal to the plane of symmetry, and others are elongated parallel to *a*, with the plane of the optical axes in the plane of symmetry. The essential characteristic of spherulitic growth is the internal structure of the spherulites. They are not made up of amorphous substances under a strain, but of definitely crystallized minerals arranged radially with one or several centres of crystallization. Under this head, according to the author, would fall granophyric intergrowths, which are radially branching aggregates of orthoclase and quartz. Cross[3] places emphasis on the valuelessness of the term microfelsite in petrographical nomenclature, as he finds the material to be an aggregate of quartz and orthoclase, two definite minerals, and not the ill-defined substance described by Rosenbusch. He attacks both Rosenbusch's and Levy's classification of spherulites as incapable of covering the handsome bodies found by himself in the

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2] *Bull. Phil. Soc.*, Washington, xi, p. 445.

[3] Ibid, xi, p. 411.

rhyolites of the Silver-Cliff-Rosita mining district in Custer County, Colorado, where spherulites occur of all sizes, up to ten feet in diameter. All are products of the consolidation of a magma, whose composition is

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 71.56 | 13.10 | .61 | .28 | .16 | .74 | .14 | 4.06 | 3.77 | 5.52 |

or about $\frac{2}{3}$ alkaline feldspar and $\frac{1}{3}$ free silica, from which nearly all of the Ca, Mg, etc., had been separated as phenocrysts of plagioclase before the formation of the spherulites. The oldest of the spherulites are minute bodies, in some of which a granophyric growth is detectable. The large ones are found in many generations. Some contain internal cavities, while others are compact. The hollow spherulites are composed of radiating branching orthoclases, with opal and other forms of silica between the fibres, forming a mass through which are scattered minute balls of tridymite or grains of quartz. Another type of spherulite is the trichitic, in which the feldspars are branched and curved to an unusual degree, forming a radiating bunch parallel to whose radii trichites of magnetite are arranged. Both hollow and trichitic spherulites are often surrounded by a supplemental growth in which the feldspar is in very delicate needles. The various generations of spherulites locally make up the entire rock, but usually there is a little residual material consisting of glass, of another radiate growth, or of a combination of both. Compound spherulites are composed of regular orientations of successive growths. The many spherulites of quartz that have been described are thought by the author to be largely feldspar and quartz aggregates, in which the orthoclase is elongated parallel to *c* with the abnormal optical orientation, and thus have a positive double refraction, when they are with difficulty distinguished from quartz microlites. Cross has traced unmistakable prismatic orthoclase down into fibres, and so seems warranted in stating that determinations of the character of the material of spherulites based entirely on the character of the double refraction of the fibres are worthless. Some of the spherulites of the Colorado occurrence consist entirely of positive feldspar, while others are composed of mixtures of this with a negative variety. With reference to the origin of spherulites, Cross reaches the same conclusion as that reached by Iddings; the mass in which spherulitic growth was set up must have come to rest and consequently must have been pasty, since fluidal lines cross the spherulites undisturbed in their courses. During the formation of some of the spherulites the mass again became pasty, and in

certain areas became colloidal, then rapid crystallization was set up and the branching forms resulted.——Though the main features of the Rapakiwi granite have long been well-known through the descriptions of Ungern-Sternberg, but little information has been granted us as to its occurrence and structural peculiarities. A recent article by Sederholm[4] gives an account of the varieties of the rock and outlines their modes of occurrence. The peculiarity common to all varieties is the occurrence of porphyritic crystals and the possession of a granophyric ground mass. The prevailing type possesses phenocrysts having an elliptical form and surrounded by a rim of oligoclase. The orthoclase is never pure, but it contains plagioclase particles and grains of quartz, and biotite or hornblende, the usual constituents of the ground mass. These inclusions are often arranged concentrically. The peculiarity of the structure of the ground mass is the idiomorphism of the quartz, which is often intergrown with the feldspar, lepidomelane and hornblende in micropegmatitic forms. The place of the orthoclase phenocrysts is sometimes taken by an aggregate of orthoclase and quartz grains, surrounded by a radiating rim of orthoclase and an exterior one of plagioclase. Miarolitic cavities are filled with fluorite. As the orthoclase becomes smaller the structure of the rock becomes more granitic, at the same time the amount of orthoclase decreases and microcline takes its place. The finest grained varieties occur as dykes in the others, and are finely granophyric. All these varieties occur in the Wiborg district in South Finland, where, on account of their remarkably easy weathering and the consequent production of granitic debris, they are well known. This easy weathering is ascribed by the author to mechanical rather than chemical agencies. At Åland and other regions types are found resembling more or less closely those described. In some porphyritic crystals of oligoclase occur in a micropegmatitic ground mass of quartz and orthoclase, and in others porphyritic quartzes in a granophyric ground mass. Between the branches of the quartz in the granophyre are small areas of coarse grain, and in these are found the miarolitic cavities. Not only do the rocks described occur in Southern Finland, but they are found also in the Southwestern portion of the same country, as well as on the islands off its coast and in the Eastern part of Sweden. All the varieties are supposed to be phases of the same magma, the coarse-grained, deep-seated facies and the granophyric surface forms. For granitic rocks with idiomorphic quartz the author proposes to use the descriptive

[4]Min. u. Petrog. Mitth., xii, p. 1.

term *anoterite*, because probably found at a less depth than the true granite. All the Rapakiwi rocks are thought to be post-archean, but not older than early Cambrian. Structurally they are supposed to represent the source of great radiating dykes and flows (Taphrolites).

——Among some rocks obtained by Doelter from the Cape Verde Islands, Eigel[5] has discovered an augite-diorite, augite-syenite, nepheline basalt, and two doubtful types, which he places respectively with the teschnites and phonolites. The augite-diorite consists of orthoclase in well-formed crystals, and gray plagioclase in lath-shaped individuals, and irregular grains of augite and hornblende. The nepheline basalt occurs as dykes in the diorite, and is composed of phenocrysts of augite and plagioclase, a few olivines and probably orthoclase in a ground mass of nepheline, plagioclase and grains of augite and hornblende. The rocks to which the author assigns a place with the teschnites consist in large part of a ground mass of altered anorthite and orthoclase, in which are brown augite and hornblende, both altered on their edges to dilorite, a little biotite, magnetite and apatite. The composition of one of these is given as:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 39.64 | 16.98 | 6.61 | 9.31 | 10.58 | 6.65 | 3.09 | 5.95 | 1.32 |

The phonolites are fine-grained rocks, made up of porphyritic crystals of acmite and red augite, sometimes zonally intergrown, and hornblende, in a ground mass consisting of microlites of hornblende, augite, biotite, orthoclase, plagioclase, muscovite and magnetite, and little grains of a colorless mineral, probably orthoclase, in an isotropic base. Nepheline could not be detected microscopically, but is supposed to be present as the result of chemical tests. One specimen contains regularly outlined icositetrahedra composed of a nucleus of calcite and sahlite, and an external zone of biotite, that are regarded as altered garnets. Since this rock occurs between a well characterized phonolite and limestone it is thought to be a contact facies of the former.

The trachytes, andesites, basalts, etc. of the Upper Eifel have been subjected to a very careful investigation by Vogelsang.[6] The phonolite and the leucite and nepheline basanites have no peculiar characteristics which need be referred to here. The basalts include plagioclase, leucite and nepheline varieties, the former two of which have effected alteration in sandstones and graywackes, with which they are in contact. The trachytes are very much like the Drachenfels rock,

[5] *Mineralog. u. Petrog. Mitth.*, 1890, xii, p. 91.

[6] *Zeit. d. d. geol. Gesell.*, xliii, 1890, p. 1.

and like some specimens of this, contains tridymite in its ground mass. The most interesting type studied is hornblende andesite. This also contains tridymite in its ground mass, and also contains parallel growths of biotite and hornblende with OP of the former parallel to $\infty P\bar{\infty}$ of the latter. The hornblende is much corroded, and new hornblende and feldspar are among the products of its solution. Large numbers of concretions are characteristic of the rock. There are granular aggregates of cordierite, andalusite, sillimanite, feldspar, biotite, pleonast, corundum, rutile, quartz, garnet, zircon and magnetite, and are sometimes schistose. The author thinks that they were originally inclusions of sillimanite-cordierite gneiss or schist that were altered by contact with the molten mass of the andesite. He strengthens his supposition by treating cordierite-sillimanite rocks with andesite material, when he obtains an abundance of pleonast, which is one of the most characteristic minerals of the aggregates.——The leucitophyres of the Laacher-See region have again been subjected to a very thorough microscopical study. Martin[7] has found them to consist principally of sanidine, leucite, nepheline, augite, and sometimes biotite and melanite phenocrysts in a ground mass of sanidine, nepheline and green augite, together with a little glassy base. He regards them as tertiary in age and separates them into two groups, according to the presence or absence of melanite. The former contain but 48.50–49.25% of $SiO_2$, while in the latter the percentage of this constituent rises to 53–54%. The mineral in the rock from Perlerkopf, thought by Rosenbusch to be perofskite, is melanite. The rocks from Seeberg, called trachyte by Zickel, are phonolites containing green and violet augite and nests of olivine. There appear to be gradations between the phonolites and fasanites. The leucite-tufa of the region is a leucitophyre-tuff and the leucitophyre-nepheline tephrites and nephelinites of the Harmebacher Ley are all nephelinites. Some of Selberg are feldspathic basalts and nepheline basalts, the latter with leucite crystals altered to zeolites and augites filled with hornblende inclusions.

At Democrat Hill and Mt. Robinson in the Rosita Hills, Col., are two vents of old solfataras, whose gases have so affected the rhyolite surrounding them that two entirely new and unique rocks have resulted. At the former place the original rhyolite is now replaced according to Mr. Cross[8] by a cellular rock composed of alunite and quartz, and sometimes a little kaolin, whose cavities are lined with

[7] *Zeit. d. d. geol. Gesell.*, xlii, p. 151.

[8] *Amer. Jour. Sci.*, June, 1891, p. 466,

crystals of the first two minerals. The alunite is tabular and has a composition:

| $SiO_2$ | $Al_2O_3$ | $K_2O$ | $Na_2O$ | $SO_3$ | $H_2O$ | $Fe_2O_3$, etc. |
|---|---|---|---|---|---|---|
| 65.94 | 12.95 | 2.32 | 1.19 | 12.47 | 4.47 | .55 |

At Mt. Robinson the alunite rock is not quite so regular in character, since it contains in places little tablets of barite. Toward the West of the ridge on the top of the mountain is another unique rock composed almost entirely of quartz and diaspore. The composition of this rock is as follows:

| $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | Alk | $SO_3$ | $P_2O_5$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 76.22 | .11 | 19.45 | tr. | tr. | tr. | .29 | .13 | 3.82 |

An analysis of the diaspore crystals implanted on the walls of its cavities yielded $Al_2O_3 = 83.97$; $H_2O = 15.43$.——Among the Archean schists of the Argentine Republic Kühn[9] finds gneisses, mica schists, quartzite and phyllite. In the last three rocks but little of special interest was noted except in the case of the quartzite, where cordierite is supposed to have been discovered. The gneisses are divided into biotitic, muscovitic, and granulitic varieties, and a variety containing two micas. Each group contains fine and medium grained kinds, and one—the biolitic group— embraces a series of "augen-gneiss." The eyes are feldspars, whose outlines indicate that they were originally phenocrysts in a porphyritic granite. Fractured crystal components, peripheral granulation of some of its constituents and an undulous extinction in others, all indicate that the rock has been subjected to enormous pressure. In connection with the discussion as to its origin the author gives an account of the views held on the subject of the origin of gneisses, and discusses their probable correctness. He concludes that gneisses produced by pressure became schistose after their constituents had formed, and that their schistosity is a direct result of the plasticity of the rock mass under pressure, and is not a consequence of numerous fracturings and re-cementings, as Lehmann would have us suppose. With reference to the chemical changes produced by dynamo-metamorphism the author gives descriptions of the alteration of garnet into biotite, and of tourmaline into pinite. He also gives an account of the weathering of garnet into hornblende, and of biotite into chlorite and epidote. The article is particularly interesting in its treatment of the characteristics of schistosity and the origin of the schistose structure.——The constituents of the pegmatite veins

[9] *Neues Jahrb. f. Min.* etc.; B. B. vii, p. 295.

cutting the crystalline schists and granites of the Western part of the Argentine Republic have been carefully examined by Sabensky.[10] They are aggregates of orthoclase, microline, quartz and mica, with plagioclase, biotite, chlorite, tourmaline, garnet, beryl, apatite, zircon and hematite as accessory components. Both the potassium feldspars are intergrown with albite lamellæ, inlaid parallel to a plane between $\infty P\overline{\infty}$ and $2P\overline{\infty}$. The microline offered a fine opportunity for the study of its characteristics. An untwinned specimen gave as a mean of the measurements of its cleavage faces the angles 89° 30.6′ and 90° 29.4′. The peculiar grid-iron structure seen in certain thin sections of the minerals are ascribed to twinning according to the albite law, and not to a combination of twins according to the albite and pericline laws. The arguments brought forward in support of this view are too involved to be dealt with in this place. They are clearly stated in the author's article. Gas and fluid inclusions were formed in the quartz, which mineral often possesses an undulous extinction. Quartz and feldspar are frequently intergrown to give rise to the graphic structure. This is explained by the author as a regular intergrowth of the two minerals in a manner analogous to that of orthoclase and albite, *i. e.*, the quartz follows easy cleavage planes in the feldspar.

**Mineralogical News.**—Of some rare Argentine minerals recently described by Klockmann[11] the following deserve notice: *Eukarite*, *Umangite* and *Luzonite*. The first named is regarded by the author as a member of the galena group, in spite of the fact that it appears to possess a foliated structure and an hexagonal habit. One analysis yielded: Ag = 43.13; Cu = 25.32: Se = 31.55, corresponding to Ag, Cu, Se, or a jolpaite in which Se replaces S. The mineral occurs in a vein with calcite and umangite, cutting a limestone of unknown age. The *umangite* has heretofore been mistaken for barite. An analysis of the purest material obtainable gave: Cu = 56.03; Ag = 49; Se = 41.44; $Co_2$, $H_2O$, etc., = 2.04, which corrected for impurities gives a result corresponding to $Cu_3 Se_2$. Its density is 5.620. The mineral, which is new, is found massive and in the form of a very full-grained granular aggregate. Its hardness is 3. It has a metallic lustre and is opaque. Its streak is black, while its color in consequence of corrosion is a dark, cherry red or violet. The name is taken from the locality in which it occurs—on the West slope of the Sierra de

[10] *Neues Jahrb. fur Min.*, etc., B. B. vii, p. 359.

[11] *Zeits. f. Kryst*, xix, 1891, p. 265.

Umango, La Rioja. *Luzonite* was described by Weisbach from Luzon, Philippine Islands, as a substance in all probability isomorphous with famatinite. It however has the composition of enargite, which according to Stelzner is not isomorphous with famatinite. Klockmann thinks the latter mineral and luzonite isomorphous, and regards luzonite as the dimorphous form of enargite. The luzonite is associated with barite as a reddish gray or light copper-red, massive substance with a hardness of 3.5 and a density 4.390. Its composition is Cu = 47.36; I = 32.40; As = 16.94; Sb = 3.08. The locality given for it is Sierra de Famatina, La Rioja.——Analyses of *astrophyllite* from the cryolite locality at St. Peter's Dome, Colo., and of *tscheffkinite* from Bedford Co., Va., yielded Eakins[12] respectively:

| $Ta_2O_5$ | $SiO_2$ | $TiO_2$ | $LrO_2$ | $ThO(YEr)_2O_3(LaDi)_2O_3Ce_2O_3Al_2O_3$ | $Fe_2O_3$ | FeO | MnO |
|---|---|---|---|---|---|---|---|
| .34 | 35.23 | 11.40 | 1.21 | | tr. | 3.73 | 29.02 | 5.52 |
| .08 | 20.21 | 18.78 | tr(?) | .85 1.82 19.72 20.05 | 3.60 | 1.88 | 6.91 | |

| CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ | Sp.Gr. | |
|---|---|---|---|---|---|---|
| .22 | .13 | 5.42 | 3.63 | 4.18 | | $R_4'' R_4' Si(SiO_4)_4$ |
| 4.05 | .55 | | .06 | .94 | 4.33 | |

The astrophyllite was very pure, so that the figures of the analysis must be regarded as representing accurately the composition of the substance, especially since they correspond so closely to the formula suggested by Brögger as the result of Bäckstroms investigation. The tscheffkinite was somewhat altered. In thin section Mr. Cross found a brownish transparent amorphous substance crossed by cracks containing reddish brown ochreous decomposition products and bands of colorless minerals that appear to be calcite and sphene, besides several darker minerals. The material analyzed by Price[13] was found upon examination to be as complex in composition, so that it seems probable that the substance has no place among minerals.——The *kamacite*, *tænite* and *plessite* found in the Welland meteorite[14] were so easily separable that Davidson[15] has succeeded in obtaining a sufficient quantity of each for analyses. The kamacite is brittle and of the color of cast iron, while tænite is silvery in lustre and is flexible. The results of the analyses are as follows:

| | Fe | Ni | Co | C |
|---|---|---|---|---|
| Kamacite . . | 93.09 | 6.69 | .25 | .02 |
| Tænite . . | 74.78 | 24.32 | .33 | .50 |

[12] *Amer. Jour. Sci.*, July, 1891, p. 34.

[13] *Amer. Chem. Jour.*, Jan. 1888, p. 38.

[14] *Howell. Proc. Rochester Ac. Sci.*, 1890, p. 86.

[15] ib., p. 64.

Both are magnetic, the latter evincing stronger polarity than the former. In etching the kamacite is attacked more rapidly than the richer alloy of nickel. Plessite was found to consist of fine lamellae of the two alloys above mentioned.——Brown[16] has carefully examined the *bernardinite* first described by J. M. Silliman,[17] from San Bernardino Co., Cal., as a new mineral resin, and has discovered it to be in all probability the fungus *Polyporus officinalis.*——Weed finds[18] that the ore deposit of the Mount Morgan gold mine in Queensland, Australia, is a siliceous sinter like that of the Yellowstone National Park, impregnated with auriferous hematite. Both the sinter and the hematite are clearly hot spring deposits. A brief abstract of a paper read by Dr. Foote[19] at the Washington meeting of the A. A. A. S., gives an account of the discovery of black and colorless *diamonds* in a fragment of meteoric iron weighing forty pounds found at Crater Mt., about two hundred miles North of Tucson, Ariz. The diamonds usually occur associated with amorphous carbon in the cavities in the mass, which contains about 3% of Ni.——Census Bulletin No. 49, by Mr. Kunz[20] contains a brief account of the value of gems and precious stones discovered and worked up in the United States during the year 1889. The total value of the materials found within the country amounted to $188,807. Agatized wood, turquoise, zircon, and quartz in the order mentioned are the most important domestic productions falling under the head of precious stones used as ornaments or gems.

[16] *Amer. Jour. Sci.*, July, 1891, p. 46.

[17] ib., xviii, p. 57.

[18] ib., Aug., 1891, p. 166.

[19] *Scientific American,* N. Y., Aug. 29, 1891, and *Amer. Jour. Sci.*, Nov., 1891, p.

[20] Census Bulletin No 49, April 14, 1891.